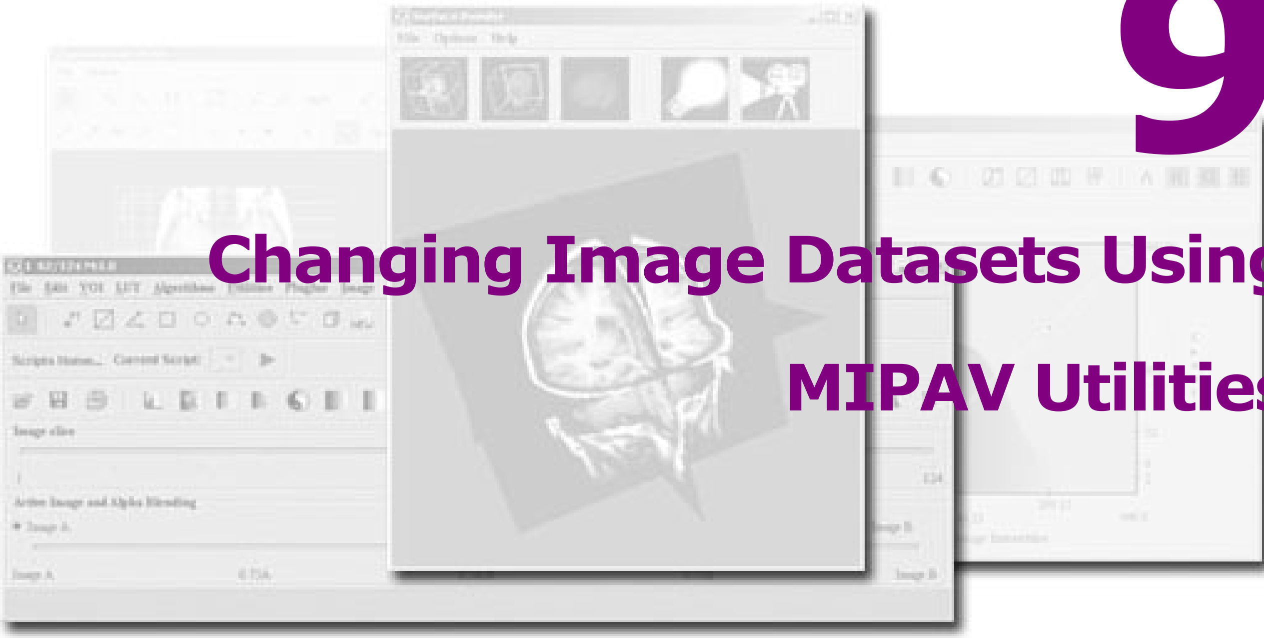
9



Changing Image Datasets Using MIPAV Utilities

In this chapter . . .

MIPAV provides a number of utilities that you can use to perform standard image-processing tasks such as converting image datasets to another image type, transforming images by copying, cropping, or rotating them, and changing image datasets by adding, removing, or reordering slices. To perform more complex tasks, MIPAV provides algorithms, which are covered in volume 2 of the *User's Guide*. This chapter explores the standard tasks.

To access the standard image-processing tasks, you use the commands (refer to Table 4) on the Utilities menu in the MIPAV window.

Table 4. Standard tasks provided through commands on the Utilities menu in the MIPAV window

Task	Command	Scalar*			RGB		
		2D	3D	4D	2D	3D	4D
Adding image margins	Add Image Margins	Y	Y	Y	Y	Y	Y
Copying images	Clone (copy)	Y	Y	Y	Y	Y	Y
Concatenating datasets	Concatenate	Y	Y	Y	Y	Y	Y
Converting datasets to a different image type	Convert Type	Y	Y	Y	N	N	N
Converting 3D to 4D	Convert 3D to 4D	N	Y	N	N	Y	N
Converting 4D to 3D	Convert 4D to 3D	N	N	Y	N	N	Y
Correcting image spacing	Correct Image Spacing	N	Y	Y	N	N	N
Cropping images	Crop	Y	Y	Y	Y	Y	Y
Removing 3D information from 4D dataset	Extract 3D Subset from 4D	N	N	Y	N	N	Y

*Scalar includes the following image types: Boolean, byte, unsigned byte, short, unsigned short, integer, long, float, and double.

Table 4. Standard tasks provided through commands on the Utilities menu in the MIPAV window (continued)

Task	Command	Scalar*			RGB		
		2D	3D	4D	2D	3D	4D
Flipping images horizontally	Flip > Horizontal	Y	Y	Y	Y	Y	Y
Flipping images vertically	Flip > Vertical	Y	Y	Y	Y	Y	Y
Converting datasets from grayscale to RGB	Grays -> RGB	Y	Y	Y	N	N	N
Creating a histogram	Histogram Summary	Y	Y	Y	Y	Y	Y
Adding slices to datasets	Insert Slice	N	Y	Y	N	Y	Y
Inverting the order of slices in datasets	Inverse Slice Order	N	Y	Y	N	Y	Y
Masking images	Mask	Y	Y	N	Y	Y	N
Matching images	Match Images	Y	Y	N	Y	Y	N
Adding noise to images	Noise	Y	Y	N	Y	Y	N
Randomizing the order of slices	Randomize Slice Order	N	Y	Y	N	Y	Y
Rotating images	Rotate -> X axis +90	Y	Y	Y	Y	Y	Y
	Rotate -> X axis -90	Y	Y	Y	Y	Y	Y
	Rotate -> Y axis +90	Y	Y	Y	Y	Y	Y
	Rotate -> Y axis -90	Y	Y	Y	Y	Y	Y
	Rotate -> Z axis +90	Y	Y	Y	Y	Y	Y
	Rotate -> Z axis -90	Y	Y	Y	Y	Y	Y
Removing slices from datasets	Remove Slices	N	Y	Y	N	Y	Y
Extracting slices from datasets	Extract Slices/ Volumes	N	Y	Y	N	Y	Y

*Scalar includes the following image types: Boolean, byte, unsigned byte, short, unsigned short, integer, long, float, and double.

Table 4. Standard tasks provided through commands on the Utilities menu in the MIPAV window (continued)

Task	Command	Scalar*			RGB		
		2D	3D	4D	2D	3D	4D
Removing time slices from datasets	Remove time slices	N	N	Y	N	N	Y
Manually converting datasets from RGB to grayscale	RGB -> Gray	N	N	N	Y	Y	Y
Automatically converting datasets from RGB to grayscale	RGB -> Grays	N	N	N	Y	Y	Y
Subsampling images	Subsample	Y	Y	N	Y	Y	N
Swapping the third and fourth dimensions	Swap DIMS 3 <-> 4	N	N	Y	N	N	Y

*Scalar includes the following image types: Boolean, byte, unsigned byte, short, unsigned short, integer, long, float, and double.

Recording utilities usage with the history feature

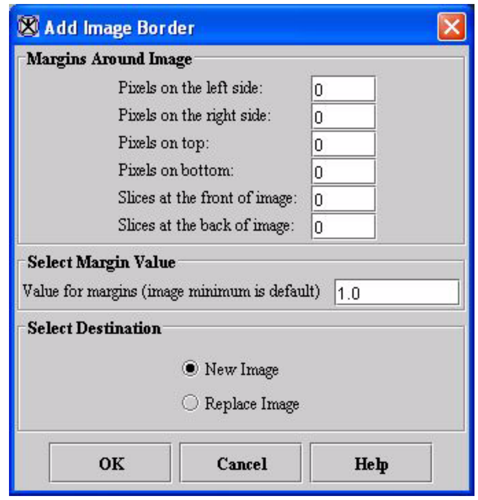
MIPAV provides a way for you to record the actions, whether with algorithms or utilities, that you perform on images. You use the MIPAV Options dialog box to turn this feature on. Refer to "Saving a history of actions on images" on page 99 in Chapter 3, "Getting Started Quickly with MIPAV"of this *User's Guide* for more information.

Adding image margins

The Add Image Margins command allows you to add a border of pixels or a specific intensity along the edges of an image dataset.

To add image margins

1. Open an image.
2. Select Utilities > Add Image Margins. The Add Image Borders dialog box (Figure 246) opens.
3. Enter the number of pixels to add on the left and right sides of the image, the top and bottom, and to the front and back of the image.
4. Enter the intensity value for the margins.
5. Select one of the following destinations:
   - *New image*—The software applies the margins to another instance of the dataset in a new image window.
   - *Replace image*—The software adds the margins to the existing instance of the dataset.
6. Click OK. The image margins are applied to the dataset.



Margins Around Image	**Pixels on the left side:** Specifies the number of pixels that should appear on the left side of the image. **Pixels on the right side:** Specifies the number of pixels that should appear on the right side of the image. **Pixels on top:** Specifies the number of pixels that should appear on the top of the image. **Pixels on bottom:** Specifies the number of pixels that should appear at the bottom of the image. **Slices at the front of image:** Specifies the number of slices that should appear at the front of the image. **Slices at the back of image:** Specifies the number of slices that should appear at the back of the image.
Value for margins (image minimum is default)	Specifies the intensity of the border around the image. As a default, the intensity of the border is the same intensity as that for the image.
New image	Shows the image with the additional or adjusted margins in a new image window.
Replace image	Replaces the current active image with the results of the image to which margins were added or adjusted.
OK	Applies the parameters that you specified to add margins to this image.
Cancel	Disregards any changes you made in this dialog box, closes the dialog box, and does not add image margins.
Help	Displays online help for this dialog box.

Figure 246. Add Image Border dialog box

Copying images using the Clone command

Suppose you need to copy an image dataset. To do so, you would use the Clone command on the Utility menu. This command generates a duplicate of the dataset and any information stored on the image, utility, algorithms, VOI, and paint layers.

Note: The Clone utility copies VOIs as well as the image, but it does not copy LUT information. Although we can observe its effects, it is not stored in an image layer.

If two datasets are loaded into one image window, only the active dataset is cloned. When the dataset is duplicated, the duplicate dataset appears in its own image window.

To copy an image dataset, you simply select Utility > Clone (copy) in the MIPAV window. In a moment or two, a duplicate of the dataset appears in a new image window.

Concatenating images

The Concatenate command on the Utilities menu provides you with a way to append, or add, two datasets together.

To concatenate image datasets

1. Open the two datasets that you want to join.
2. Select the dataset to which you want to append the other dataset.
3. Select Utilities > Concatenate. The Concatenate Images dialog box (Figure 247) opens.
4. Note that the dataset you selected appears in read-only form in the box labeled Image A.
5. Select Image B, which is the name of the dataset that you want to add to the end of Image A.

6 Select the dimensionality that you want for the resulting dataset by selecting either 3D or 4D.

Note: If both datasets contain the same number of slices, you can select either 3D or 4D. If the datasets contain a different number of slices, you can only select 3D.

7 Click OK. The program adds the Image B dataset to the end of the Image A dataset and displays the resulting dataset in a new image window.

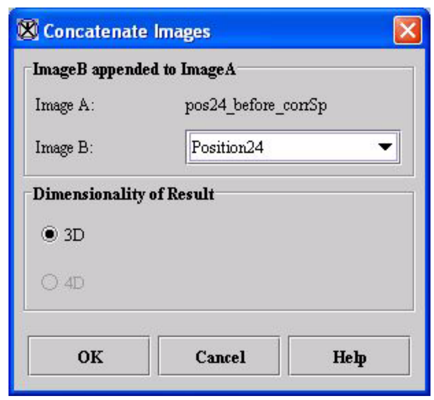


Image A	Specifies the name of the dataset to which to append Image B. This dataset is the one you selected before using the Concatenate command.
Image B	Specifies the name of the dataset that you want to append to the Image A dataset.
3D	Indicates that the dataset that results from appending Image B to Image A is three dimensional.
4D	Indicates that the dataset that results from appending Image B to Image A is four dimensional.
OK	Applies the changes you made in this dialog box and closes the dialog box.
Cancel	Disregards any changes you made in this dialog box, closes the dialog box, and does not append Image B to Image A.
Help	Displays online help for this dialog box.

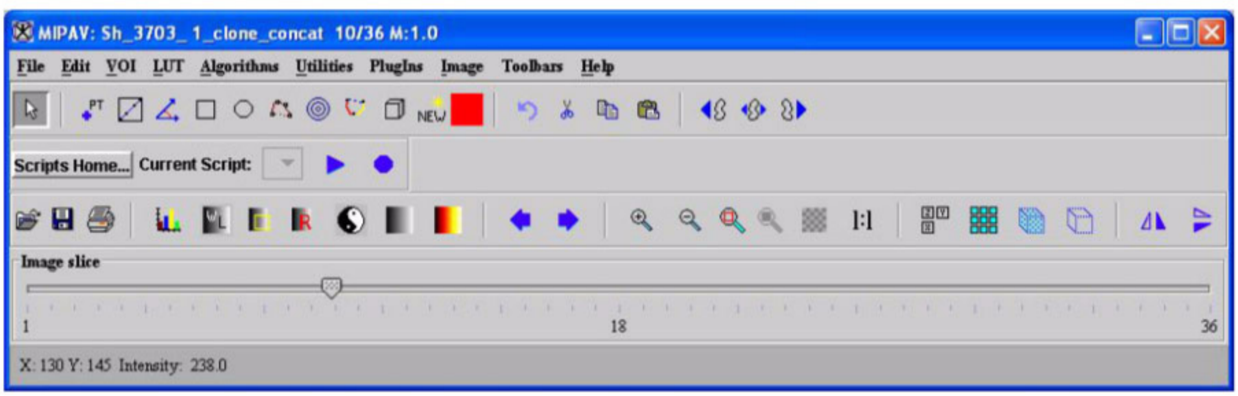
Figure 247. Concatenate Images dialog box

To verify that the datasets are joined

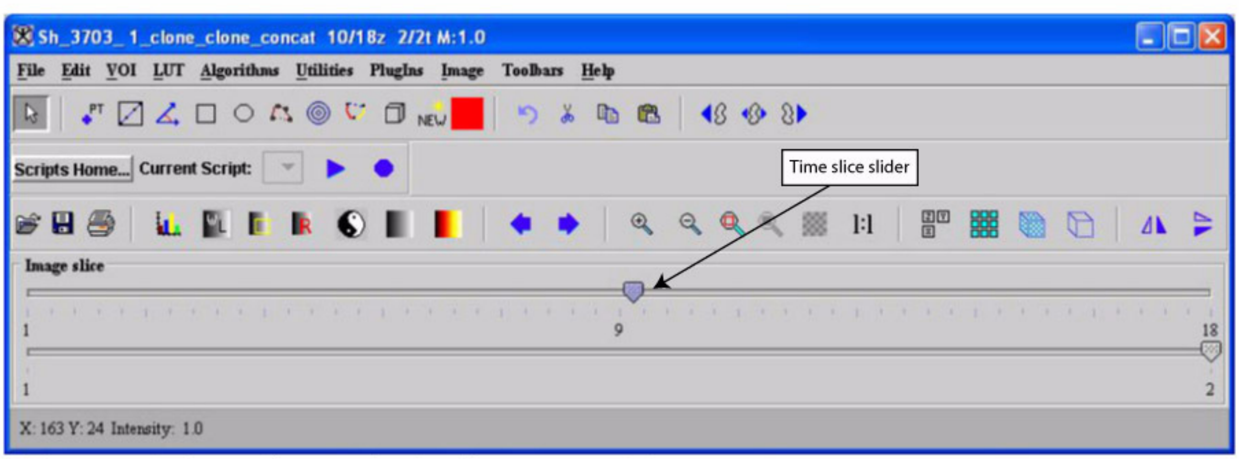
1 Select the new dataset that resulted from concatenating the Image A and Image B datasets.

2 Notice the following on the MIPAV window:

- If you selected 3D as the dimensionality of the resulting dataset in the Concatenate Images dialog box, the image slice slider (Figure 248A) lists twice as many slices as either the Image A and Image B datasets.
- If you selected 4D as the dimensionality of the resulting dataset, a time slice slider (Figure 248B) appears beneath the image slice slider and the image slice slider lists the same number of slices as the Image A and Image B datasets.



(A) After concatenating datasets that contain the same number of slices to generate a 3D dataset



(B) After concatenating datasets with an unequal number of slices to generate a 4D dataset

Figure 248. The MIPAV window after concatenating datasets to generate 3D or 4D datasets

Converting image datasets to different data types

In MIPAV you can convert image datasets to different data types. For example, you might want to convert a Boolean type dataset to an integer type dataset. MIPAV also allows you to simultaneously alter the input and output values. This utility is particularly helpful if you want to apply an algorithm to a dataset but cannot do so because the original images are the wrong image type.

data type—A set of values from which a variable, constant, function, or expression may takes its value. MIPAV automates the following data types: Boolean, signed byte, unsigned byte, signed short, unsigned short, integer, long, float, double, and color 24.

To convert a dataset to a different image type

1. Select Utilities > Convert type. The Convert Image Type dialog box (Figure 249) opens.
2. Select the desired image type in the Image Type group.
3. Indicate the start and end input ranges in the Range of input values group.
4. Indicate the start and end output ranges in the Range of output values group.
5. Specify either Little endian or Big endian in the Endianess group.
6. Click OK. The dataset is converted to the new image type.

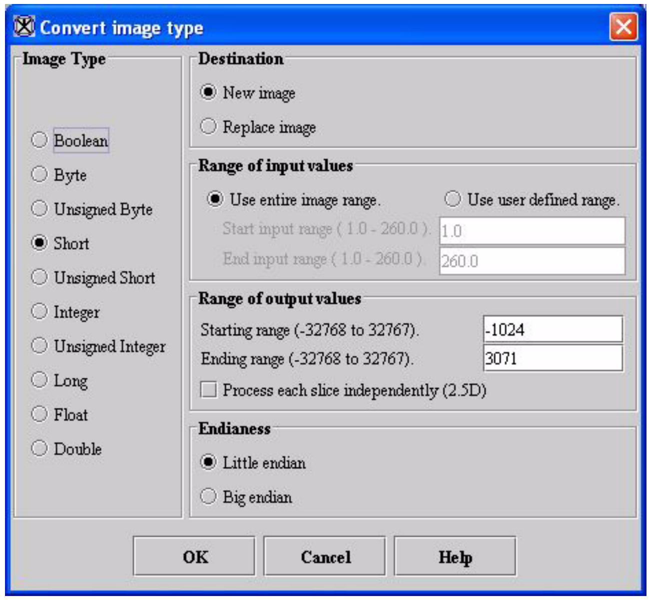


Image Type	Specifies the data type. Select one of the following:	
	Boolean	Indicates whether a condition if true or false.
	Byte	Primitive 8-bit data type. Valid values range from -127 to 128.
	Unsigned byte	Primitive 8-bit data type. Unsigned byte is a variation of the integer data type. The unsigned byte data type signifies that valid values must fall within a specified range of positive whole number values. Valid values range from 0 to 255. Negative values are not valid, hence the term *unsigned byte*.

Figure 249. Convert Image Type dialog box

	Short	Primitive 16-bit data type. Short is a variation of the integer data type. Short accommodates values that are whole numbers. Valid values range from 0 to +32,768.
	Unsigned short	Primitive 16-bit data type. Unsigned short is a variation of the integer data type. The unsigned short data type signifies that valid values must fall within a specified range of positive whole number values. Valid values range from 0 to 65,535. Note that negative values are not valid, hence the term *unsigned byte*.
	Integer	Primitive 32-bit data type. Integer is sometimes abbreviated as int. Integer accommodates values that are whole numbers. Valid values range from -2,147,483,648 to +2,147,483,648.
	Unsigned integer	Primitive 32-bit data type.
	Long	Primitive 64-bit data type. Long is a variation of the integer data type. Long accommodates values that are whole numbers. Valid values range from -9,223,372,036,854,775,808 to +9,223,372,036,854,775,808.
	Float	Primitive 32-bit data type. Float is a floating point data type that accommodates decimal values, up to 6 or 7 significant digits of accuracy. Valid values can range from -3.4 x 10^{38} to 3.4 x 10^{38}.
	Double	Primitive 64-bit data type. Double is a floating point data type that accommodates decimal values, up to 14 or 15 significant digits of accuracy. Valid values can range from -1.7 x 10^{308} to 1.7 x 10^{308}.
Destination	*New image*	Shows the converted dataset in a new image window.
	Replace image	Replaces the current active dataset with the converted dataset.
Range of input values	*Use entire image range*	Converts all intensity values to the result image range when converting the image to a different type.
	Use user-defined range	Converts only the intensity values in the user-defined range when converting the image to a different type.
	Start input range	Specifies the intensity value at the beginning of the input range. The default value is the image minimum.
	End input range	Specifies the intensity value at the end of the input range.

Figure 249. Convert Image Type dialog box (continued)

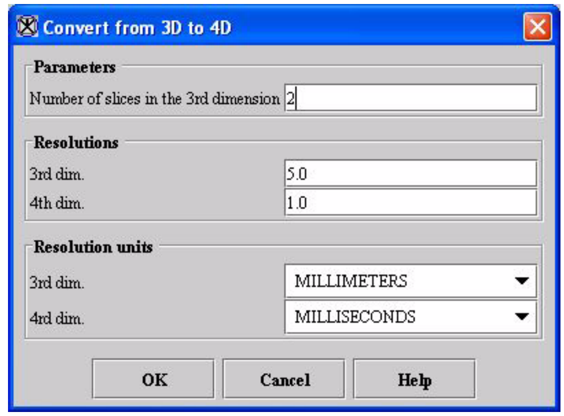
Range of output values	*Starting range*	Specifies the intensity value at the beginning of the output range. The default value is the image minimum.
	Ending range	Specifies the intensity value at the end of the output range.
Endianess	Data organization strategy. Refers to the way computer processors store data in memory.	
	Little endian	Stores the least significant byte (LSB) first.
	Big endian	Stores the most significant byte (MSB) first.
OK	Applies the parameters that you specified to convert the dataset.	
Cancel	Disregards any changes you made in this dialog box, closes the dialog box, and does not convert the dataset.	
Help	Displays online help for this dialog box.	

Figure 249. Convert Image Type dialog box (continued)

Converting 3D to 4D images or 4D to 3D images

To convert 3D images to 4D images

1. Open a 3D image or image dataset.
2. Select Utilities > Convert 3D to 4D. The Convert 3D to 4D dialog box opens.
3. Do either of the following in the Number of slices in the 3rd dimension, Resolutions: 3rd dimension, and Resolutions: 4th dimension boxes:
   - Accept the default numbers.
   - Enter different numbers.
4. Select in each of the Resolution units: 3rd dimension and Resolutions units: 4th dimension lists one of the following: millimeters (the default value), unknown, inches, centimeters, angstroms, nanometers, micrometers, milliliters, meters, kilometers, miles, nanoseconds, microseconds, milliseconds, seconds, minutes, hours, or Hz.
5. Click OK. The program applies all of the specification in this dialog box to the image or image dataset.



Number of slices in the 3rd dimension	Specifies how many slices are in the 3rd dimension. The default number is 2.
Resolutions: 3rd dimension	Indicates the resolution for the third dimension. The default number is 5.0.
Resolutions: 4th dimension	Indicates the resolution for the fourth dimension. The default number is 1.0.
Resolution units: 3rd dimension	Indicates the voxel resolution in the 3rd dimension.
Resolution units: 4th dimension	Indicates the voxel resolution of the 4th dimension.
OK	Applies the specified parameters to convert a 3D image to a 4D image.
Cancel	Disregards any changes you made in this dialog box, closes the dialog box, and does not convert the image.
Help	Displays online help for this dialog box.

Figure 250. Convert from 3D to 4D dialog box

To convert 4D to 3D images

1 Open a 4D image or image dataset.

2 Select Utilities > Convert 4D to 3D.

The program immediately begins processing the image.

Correcting image spacing

The Correct Image Spacing command on the Utilities menu corrects images in which slice thickness and slice spacing are unequal, which may distort images. To understand how this problem can occur, the following section presents some background information.

UNDERSTANDING CONTIGUOUS PLANES' EFFECT ON IMAGE SCANNING

Image scanning is usually done in contiguous planes. For example, if the first slice is centered at position 5.0 and the slices are 2 mm thick, the second slice is centered at 7.0. In such a case, the slice thickness, 2, and the slice spacing, 2, are equal. There are, however, two scenarios when the slice spacing does not equal the slice thickness:

- **Slice spacing is less than the slice thickness**—In this case, although the images are, for example, 2 mm thick, they are spaced only 1 mm apart (Figure 251). This scenario arises when the ZIP x 2 feature is used during MRI scanning, which enables the acquisition of slices only 1 mm apart but uses signals from a 2-mm slab to increase the signal-to-noise ratio.
- **Slice spacing is greater than the slice thickness**—This scenario (Figure 251), which is more common than the first, occurs when the operator chooses to acquire images at intervals greater than the slice thickness (i.e., there is a gap between successive image slices) in order to cover a deeper field of view.

MIPAV assumes that successive images are contiguous. So, for example, if users chose the triplanar view to display an image that had slice spacing larger than slice thickness, the image would appear shortened in the out-of-plane direction. The Correct Image Spacing utility corrects both situations in which the slice thickness and spacing are not equal. Once the correction is applied, the slice thickness and slice spacing for the given image dataset are the same.

UNDERSTANDING HOW MIPAV SOLVES THIS PROBLEM

When the spacing between slices is *less* than the slice thickness, the Correct Image Spacing utility assigns the slice spacing to the slice thickness (refer to Figure 251 on page 379 for triplanar views before and after correction). When the slice spacing is *larger* than the slice thickness (refer to Figure 251 on page 379 for triplanar views before and after correction), the utility inserts blank slices between the existing images.

Since all slices within an image volume must have the same slice thickness, in many cases more than one slice must be inserted and the original images must be repeated so that a new value can be found for the slice thickness that fits evenly into the original slice spacing. Since there are an infinite number of combinations of slice spacing and thickness, not all could be handled. Table 5 displays the most common combinations and the algorithms MIPAV uses for handling them.

T = Original slice thickness

S = Original space between slices

G = Gap = $S - T$

M = Number of original images

O = Original image set origin

N = New slice thickness

To use the Correct Image Spacing utility, DICOM images must first be saved in XML format. The following DICOM tags (Figure 251 on page 379) are used:

- (0018, 0050) Slice Thickness
- (0018, 0088) Spacing Between Slices

You can also find this information listed in the Essential Image Information section of the image header (Figure 251 on page 379) as Pixel resolution 2 (i.e., slice thickness) and Slice Spacing.

To view image attributes

1. Open an image.
2. Select Image > Attributes > View Header. The Header dialog box (Figure 251) opens.
3. Find the tags under Essential Image Information to find the values for Pixel resolution 2 and Slice Spacing, or find the values of the DICOM tags Slice Thickness and Spacing Between Slices.

Table 5. Solutions for correct image spacing

Case	New slice thickness (*N*)	Number of images in new set for each original image	Number of blanks inserted for each original image	Total images in set now	New image set origin $\left(O - \frac{T}{2} + \frac{N}{2}\right)$
$T = S$	T	1	0	M	O
$S < T$	S	1	0	M	O
$G > O$ and $\frac{G}{T} mod 1 = 0$	T	1	$1 \cdot \frac{G}{T}$	$\left(1 + \frac{G}{T}\right) \cdot M$	$O - \frac{T}{2} + \frac{(N)}{2}$
$G > O$ and $\frac{T}{G} mod 1 = 0$	G	$1 \cdot \frac{T}{G}$	1	$\left(1 + \frac{T}{G}\right) \cdot M$	$O - \frac{T}{2} + \frac{(G)}{2}$
$G > O$ and $\left(2 \cdot \frac{G}{T}\right) mod 1 = 0$	$\frac{T}{2}$	2	$2 \cdot \frac{G}{T}$	$\left(2 + 2 \cdot \frac{G}{T}\right) \cdot M$	$O - \frac{T}{2} + \frac{\left(\frac{N}{2}\right)}{2}$
$G > O$ and $\left(2 \cdot \frac{T}{G}\right) mod 1 = 0$	$\frac{G}{2}$	$2 \cdot \frac{T}{G}$	2	$\left(2 + 2 \cdot \frac{T}{G}\right) \cdot M$	$O - \frac{T}{2} + \frac{\left(\frac{G}{2}\right)}{2}$
$G > O$ and $\left(3 \cdot \frac{G}{T}\right) mod 1 = 0$	$\frac{T}{3}$	3	$3 \cdot \frac{G}{T}$	$\left(3 + 3 \cdot \frac{G}{T}\right) \cdot M$	$O - \frac{T}{2} + \frac{\left(\frac{N}{3}\right)}{2}$
$G > O$ and $\left(3 \cdot \frac{T}{G}\right) mod 1 = 0$	$\frac{G}{3}$	$3 \cdot \frac{T}{G}$	3	$\left(3 + 3 \cdot \frac{T}{G}\right) \cdot M$	$O - \frac{T}{2} + \frac{\left(\frac{G}{3}\right)}{2}$
else	don't handle, give message				

Legend:

T = Original slice thickness

S = Original space between slices

G = Gap = *S* - *T*

M = Number of original images

O = Original image set origin

N = New slice thickness

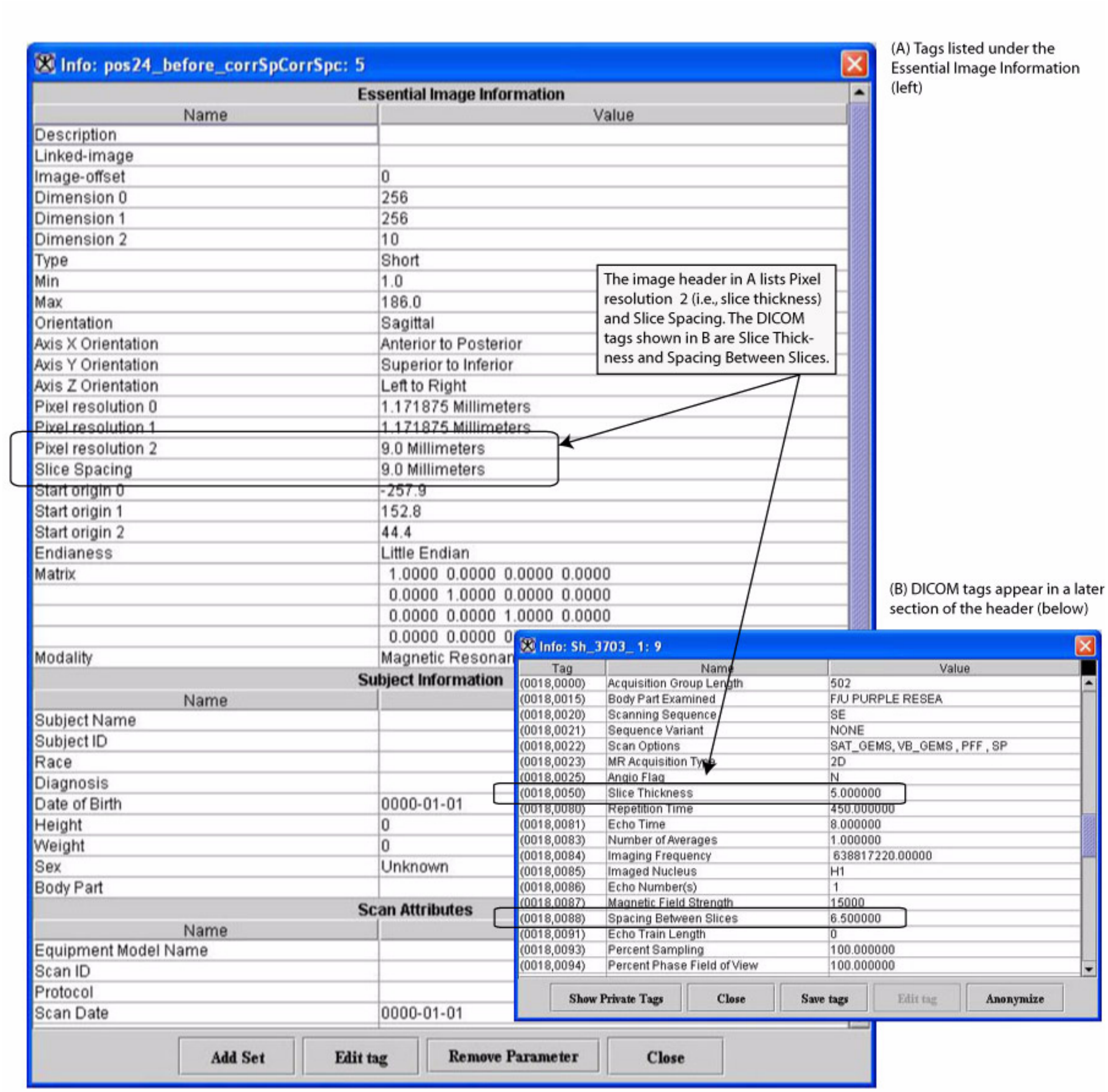


Figure 251. Views of the Header dialog box showing the tags listed under (A) Essential Image Information and (B) the DICOM tags in a later section of the header.

To save images as XML files

The Correct Image Spacing utility works only on XML files.

1 Open the image that has spacing problems if you have not already done so.

2 Select File > Save Image as in the MIPAV window. The Open dialog box appears.

3 Type the name for the file including the XML extension in File Name.

4 Select Medical, which includes XML files, in Files of Type. The Choose File Type dialog box (Figure 252) opens.

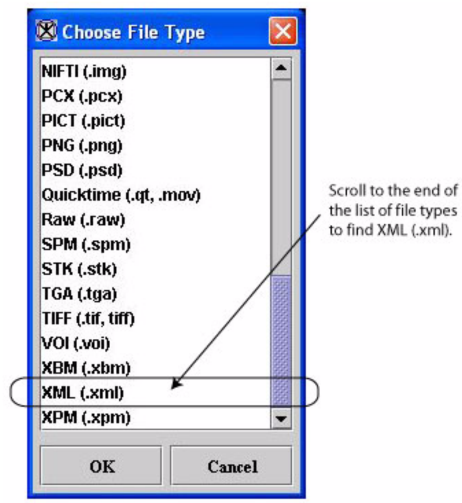


Figure 252. Choose File Type dialog box

5 Scroll down and select XML.

6 Click OK. The program saves the image as an XML file.

To correct image spacing

1 Open the image that contains spacing problems.

Tip: To determine whether images contain spacing problems, remember to view them using the triplanar view or to view the header file.

2 Save the image as an XML file.

3 Select Utility > Correct Image Spacing.

If the image file does have spacing problems, then the program runs the utility.

If the image spacing is correct, the program displays a message (Figure 253) indicating that the spacing is correct.

Figure 253. Message received when image spacing is already correct

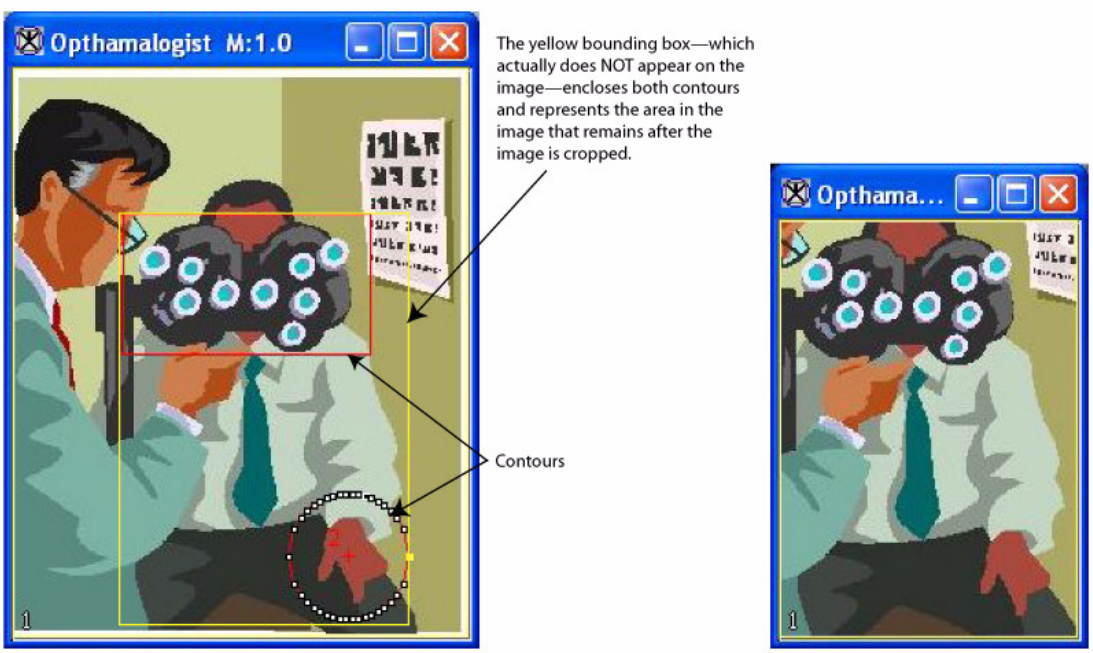
Cropping images

You can use the Crop command on the Utilities menu to trim an image so that only the selected portion of the image remains.

To crop an image

1 Open an image.

2 Draw one or more contours on the image on the area that you want to remain in the image. When the utility is run, the area inside the contours remains and the areas outside the contour are discarded from the new dataset.



(A) This picture shows two selected contours: a red rectangular one and a red circular contour.

(B) The cropped image formed from the outermost points in the two contours.

Figure 254. Contouring the area that should remain in the cropped image

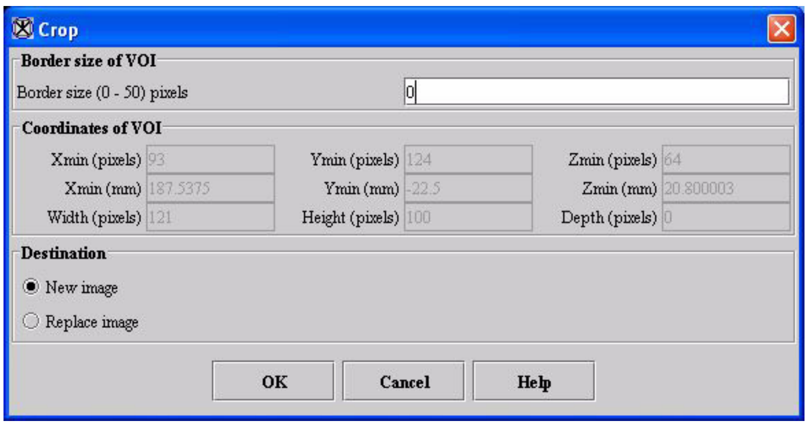
3 Select the VOI or one or more of the contours.

4 Select Utilities > Crop. The Crop dialog box (Figure 255) appears.

5 Type the number of pixels that you want to use for the border size in Border size box. Specify a number from 0 to 50.

6 Select either the New image or the Replace image check box to indicate whether the program should display the cropped image in a new image window or replace the original image with the cropped image.

7 Click OK. After a moment, the new image appears.



Border size of VOI: **Border size (0 - 50)**	Indicates the width of a strip of voxels that surround (border) the contours. When you crop an image, the area inside the contours and the border remain. All other voxels are trimmed from the image.
Coordinates of VOI	Displays the coordinates for the X, Y, and Z axes of the VOI.
New image	Shows the cropped image in a new image window.
Replace image	Replaces the current active image with the cropped image.
OK	Applies the parameters that you specified to crop the image.
Cancel	Disregards any changes you made in this dialog box, closes the dialog box, and does not crop the image.
Help	Displays online help for this dialog box.

Figure 255. Crop dialog box

Removing 3D subset from 4D

This utility allows you to remove one of the *x, y, z,* or *t* dimensions from 4D images to produce a 3D image.

To remove an *X* dimension slice

1. Open a 4D image.
2. Select Utilities > Extract 3D Subset from 4D. The Extract 3D Subset dialog box (Figure 256) opens.
3. Select X.
4. Type the index number of the slice you want to extract in the Select index from. <*N*> to <*N*> box.
5. Click Remove. The program removes the slice you specified from the dataset.

To remove a *Y* dimension slice

1. Open a 4D image.
2. Select Utilities > Extract 3D Subset from 4D. The Extract 3D Subset dialog box (Figure 256) opens.
3. Select Y.
4. Type the index number of the slice you want to extract in the Select index from. <*N*> to <*N*> box.
5. Type the index number of the slice you want to extract in the Select index from. <*N*> to <*N*> box.
6. Click Remove. The program removes the slice you specified from the dataset.

To remove a *Z* dimension slice

1. Open a 4D image.
2. Select Utilities > Extract 3D Subset from 4D. The Extract 3D Subset dialog box (Figure 256) opens.

3 Select Z.

4 Type the index number of the slice you want to extract in the Select index from. <*N*> to <*N*> box.

5 Click Remove. The program removes the slice you specified from the dataset.

To remove the *T* dimension

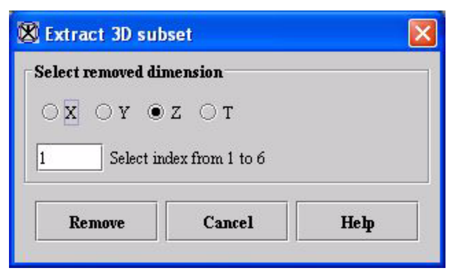
1 Open a 4D image.

2 Select Utilities > Extract 3D Subset from 4D. The Extract 3D Subset dialog box (Figure 256) opens.

3 Select T.

4 Type the index number of the slice you want to extract in the Select index from. <*N*> to <*N*> box.

5 Click Remove. The program removes the slice you specified from the dataset.



X	Specifies that the algorithm should remove the *X* (width) dimension.
Y	Specifies that the algorithm should remove the *Y* (height, or length) dimension.
Z	Specifies that the algorithm should remove the *Z* (depth) dimension.
T	Specifies that the *T* (time) dimension should be removed.
Index from <N> to <N>	Specifies the index number of the volume or slice that you want to extract from the dataset.
Remove	Removes the specified dimension.
Cancel	Disregards any changes you made in this dialog box, closes the dialog box, and does not remove any dimensions.
Help	Displays online help for this dialog box.

Figure 256. Extract 3D Subset dialog box

Extracting slices/volumes

The Extract Slices/Volume utility makes copies of the slices or volumes you select and displays them in separate image windows. Unlike the Remove Slices utility, the original image dataset is untouched.

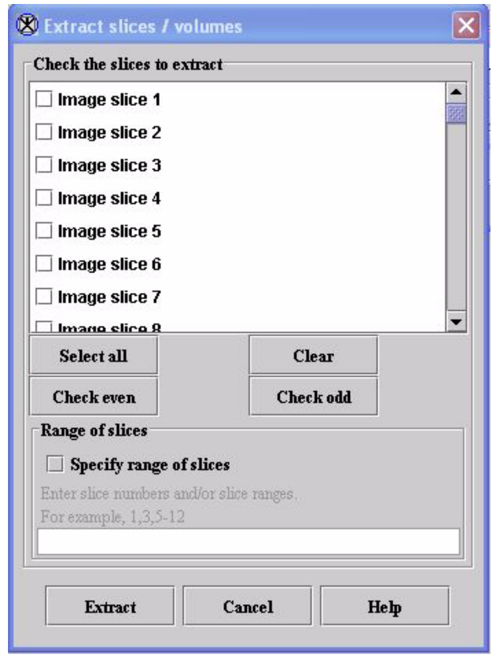
There are several ways to select slices or volumes. You can select all slices; only specific slices; only the even-numbered slices; only the odd-numbered slices; or one or more ranges of slices.

To extract slices or volumes from image datasets

1. Select Utilities > Extract Slices/Volumes. The Extract Slices/Volumes dialog box opens.
2. Use the image slider in the MIPAV window to locate slices that you want to extract.
3. Decide whether to remove:
   - *All of the slices*—Click Select all. Check marks appear in all of the image slice check boxes.
   - *One or more slices*—Select the specific check boxes for the image slices. Check marks appear in only the check boxes you selected.
   - *One or more ranges of slices*—Select Specify range of slices, and then type the slice numbers or ranges of slice numbers in Enter slice numbers and/or slice ranges box.
   - *All even-numbered slices*—Click Check even. Check marks appear in only those check boxes for even-numbered slices, such as 2, 4, 6, and so on.
   - *All odd-numbered slices*—Click Check odd. Check marks appear in only those check boxes for odd-numbered slices, such as 1, 3, 5, and so on.

Tip: Use the image slider on the MIPAV window to look at specific slices to decide which slices to remove.

4. Click Extract. A status message appears. Then the MIPAV window refreshes and the slices you selected appear in new image windows.



Check the slices to extract	Indicates the slices that you want to extract from the dataset. You can scroll through the list to select one or more slices.
Select all	Selects all of the slices in the dataset to extract.
Clear	Clears all of the slices that are currently selected.
Check even	Selects all of the even-numbered slices to extract.
Check odd	Selects all of the odd-numbered slices to extract.
Specify range of slices	Indicates that you want to extract one or more specific slices or a range of slices from the dataset. If you select this check box, you must specify the slices or ranges of slices you want to extract in the Slice number and/or range of slices box below.
Enter slice numbers and/or slice ranges	Indicates the slices and range of slices that you want to extract. This box only becomes available after you select Specify range of slices.
Extract	Makes copies of the slices/volumes you selected and displays them in separate image windows.
Cancel	Disregards any changes that you made in this dialog box and closes the dialog box.
Help	Displays online help for this dialog box.

Figure 257. Extract Slices/Volumes dialog box

Flipping images horizontally or vertically

MIPAV allows you to flip images either horizontally or vertically. To flip an image, select either Utilities > Flip > Horizontal or Utilities > Flip > Vertical. After a few moments, the flopped image replaces the original image in the same image window.

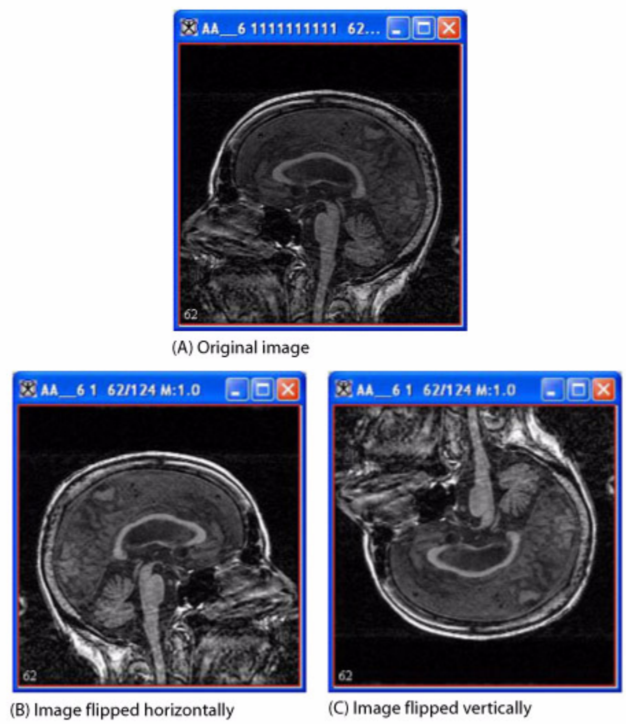


Figure 258. Original image and image flipped horizontally and vertically

Converting grayscale images to RGB images

You can convert grayscale image datasets to RGB. RGB images have three channels (red, green, and blue) that contain image data.If you open two datasets in one image window, you can create a composite image that contains a mixture of the red, green, and blue channels.

To convert grayscale images to RGB images

1 Open an image.

2 Select Utilities > Grays -> RGB. The Concatenate -> RGB dialog box opens.

3 Select the image to which you want to apply the red channel in the Image (red) list. If you loaded two images into the image window, two file names should appear.

4 Do the same for the Image (green) list and the Image (blue) list.

5 Indicate whether you want to remap to current intensity values to the full standard 0–255 RGB values.

Note: Generally, each color is defined as one of the 256 intensities. If you remap the grayscale intensities and select Remap data, the system defines the intensities as one of the 256 values. If one or all of the input images have values that exceed 255 and you do *not* select Remap data, then data truncates to 255 since a color channel can only represent values 0–255.

6 Click OK. A status message appears. When filtering is complete, the new RGB image appears in a separate image window.

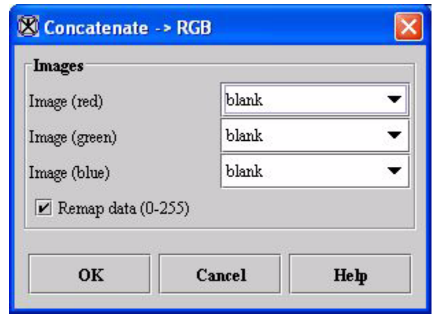


Image (red)	Identifies the image to be added to the red channel of the resulting image.
Image (green)	Identifies the image to be added to the green channel of the resulting image.
Image (blue)	Identifies the image to be added to the blue channel of the resulting image.
Remap data (0-255)	Indicates, when selected, that you want image intensities to be remapped to values 0-255, which is the standard for RGB images.
OK	Applies the parameters that you specified to create an RGB image.
Cancel	Disregards any changes you made in this dialog box, closes the dialog box, and does not create an RGB image.
Help	Displays online help for this dialog box.

Figure 259. Concatenate -> RGB dialog box

Creating a histogram summary

Sometimes it is more useful to display information in graphical form. At other times, a tabular form is easier to use. In MIPAV, you can view the frequency, or intensity level, distribution in an image or VOI region in either form. To view the information as a graphic representation, you would use either the LUT icon  on the image toolbar or the LUT menu in the MIPAV window (refer to “Improving contrast by generating and modifying histograms” in Chapter 3, “Getting Started Quickly with MIPAV”). However, to view the information in a tabular form, you use the Histogram Summary command on the Utilities menu.

You can also save the histogram summary information in a TXT (*.txt*) file.

To create a histogram summary on an entire image

1 Open an image.

2 Select Utilities > Histogram Summary in the MIPAV window. Frequency distribution information appears on the Global Data page and on the Data page in the Output window (Figure 260).

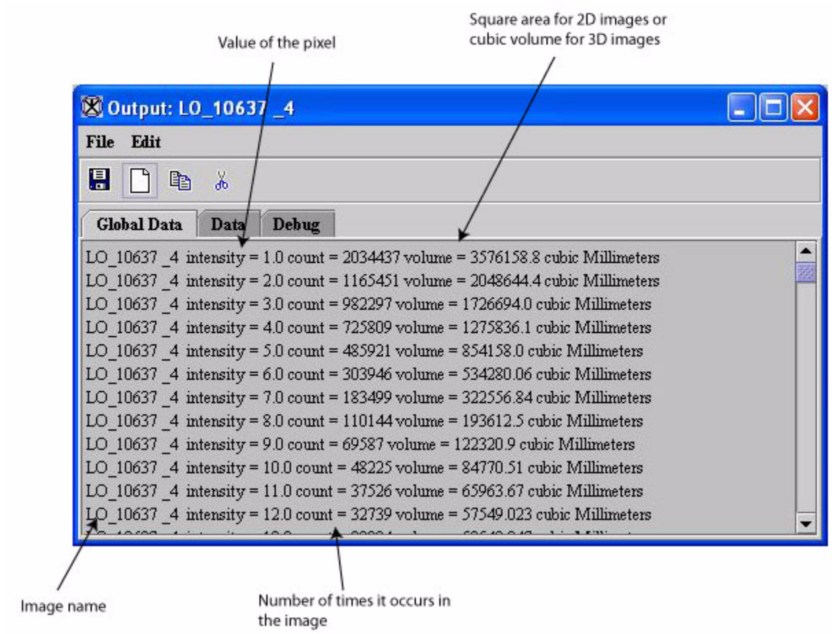


Figure 260. Histogram summary in the Output window

The histogram summary table includes the following four columns:

- **Image name**—Name of the image
- **Intensity value**—Value of the pixel
- **Count**—Number of times that pixels of this intensity value occur in the image
- **Square area or cubic volume**—For 2D images, $\text{area} = \text{count} \times x \text{ resolution} \times y \text{ resolution}$. For 3D images, $\text{volume} = \text{count} \times x \text{ resolution} \times y \text{ resolution} \times z \text{ resolution}$.

To create a histogram summary on a VOI

1. Open an image.
2. Delineate a VOI on the image.
3. Select the VOI.
4. Select Utilities > Histogram Summary in the MIPAV window. Frequency distribution information appears on the Global Data page and on the Data page in the Output window.

To save the histogram summary

1. Select  or File > Save Messages in the Output window. The Save dialog box opens.
2. Type a name and extension in File Name. Make sure that you use the *.txt* extension.
3. Click Save. MIPAV saves the histogram summary under the specified name.

Inserting slices into image datasets

When you change an image dataset, you are inserting or removing slices in the dataset or changing their order.

You can use the Insert Slice command on the Utilities menu to insert a slice into an image dataset. Although you cannot insert a slice from another file, you can insert either a blank slice or a new slice that is an average of two adjacent slices in the dataset.

To insert slices into image datasets

1. Select Utilities > Insert Slice. The Insert Slice dialog box appears.
2. Enter the number of the new slice position in the Insert before slice (1-124) or enter 125 for new last slice box.

3 Select either the Average or Blank radio button. If you select Average, MIPAV analyzes the slices immediately before and after the new slice in the dataset. The software then generates an intermediary composite by morphing the two slices. This composite becomes the new slice. If you select Blank, MIPAV inserts a blank slice in the dataset.

4 Click OK. MIPAV inserts the new slice into the dataset and opens the new dataset in a new image window.

Insert before slice (1-124) or enter 125 for new last slice	Specifies the position of the new slice.
Average	Inserts a slice that is the average the adjacent slices.
Copy previous adjacent	Insert a slice that is a copy of the preceding slice.
Copy next adjacent	Inserts a slice that is a copy of the following slice.
Blank	Inserts a blank slice.
Original	Inserts an image from the original dataset.
OK	Applies the parameters that you specified to insert the slice in the image dataset.
Cancel	Disregards any changes you made in this dialog box, closes the dialog box, and does not insert the slice into the image dataset.
Help	Displays online help for this dialog box.

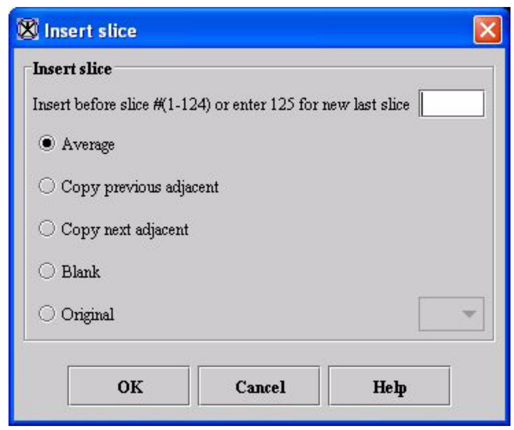


Figure 261. Insert Slice dialog box

Inverting the order of images (slices) in datasets

As its name implies, the Inverse Slice Order command on the Utilities menu reverses the order of the slices in a dataset.

To invert the order of images in datasets

1 Open an image that contains slices.

2 Use the image slider in the MIPAV window to locate slices that you want to inverse.

3 Select Utilities > Inverse Slice Order.

A status message appears and indicates that the software is reordering the slices in the dataset. In a moment or two the MIPAV window refreshes, and the image window in which the original dataset appeared displays the reordered slices.

Masking images

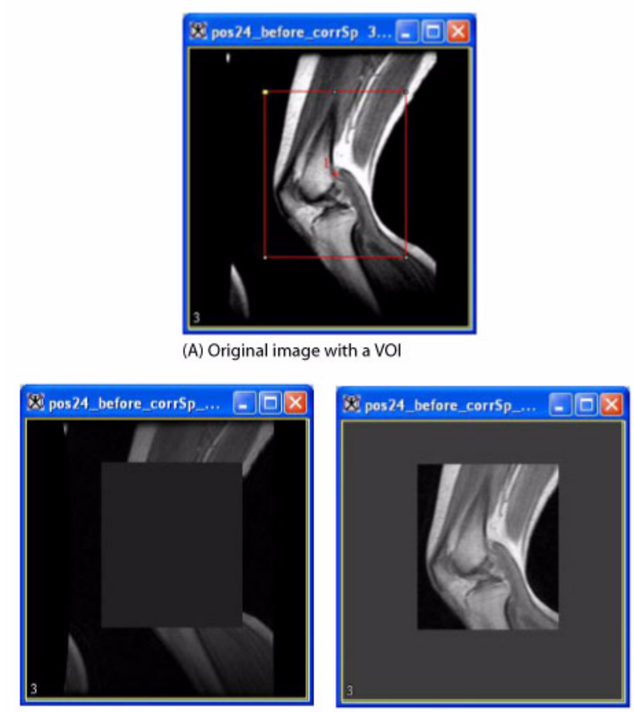
Masks allow you to remove portions of images and display only those portions as separate image files. For example, you may only be interested in a section of an image and only want to display and work with that section.

To create a mask, you first need to create one or more VOIs on the image. Depending on the type of mask you want to create, the VOIs should do either of the following:

- Enclose the image areas you want to preserve
- Enclose the image areas you do *not* want to preserve

If the VOIs indicate the areas of the image that should be deleted from the image, you need to create an *interior mask* and specify the number of pixels the program should use to hide the image inside the VOIs, or interior (Figure 262B).

To preserve the image inside the VOIs, however, you need to create an *exterior mask*. An exterior mask fills the image outside of the VOIs with the number of pixels you specify. This filling hides the portions of the image outside the VOIs, or exterior (Figure 262C).



(A) Original image with a VOI

(B) Interior fill mask

(C) Exterior fill mask

Figure 262. Interior and exterior masks

To create an interior mask

1. Open an image.
2. Create one or more VOIs that enclose the portions of the image that interest you.
3. Select Utilities > Mask. The Mask dialog box (Figure 263) opens.
4. Type the number of pixels to fill the interior of the VOIs.
5. Select Interior fill.

6 Select either New Image or Replace Image depending on which you prefer.

7 Click OK. The program either displays a new image or replaces the current image with an image that hides the portions of the image that are inside the VOIs (Figure 262B).

To create an exterior mask

1 Open an image.

2 Create one or more VOIs that enclose the portions of the image that interest you.

3 Select Utilities > Mask. The Mask dialog box (Figure 263) opens.

4 Type the number of pixels to fill the interior of the VOIs.

5 Select Exterior fill.

6 Select either New Image or Replace Image depending on which you prefer.

7 Click OK. The program either displays a new image or replaces the current image with an image that hides the exterior of the image outside the VOIs (Figure 262C).

Parameters	Specifies the value in pixels to fill the VOI.
Interior fill	Applies the value to the interior of the VOI.
Exterior fill	Applies the value to the exterior of the VOI.
New image	Shows the cropped image in a new image window.
Replace image	Replaces the current active image with the cropped image.
OK	Applies the parameters that you specified to mask the image.
Cancel	Disregards any changes you made in this dialog box, closes the dialog box, and does not mask the image.
Help	Displays online help for this dialog box.

Figure 263. Mask Image dialog box

Matching images

The Match Images command on the Utilities menu assists in any comparison of two images. To use this utility, you need to first open two images: image A, which has the desired characteristics, and image B, whose characteristics need to match those of Image A. The Match Images dialog box presents the following four ways in which you can match the images:

- **Match image orientation**—Rotates Image B so that its orientation is the same as the orientation of image A.
- **Match resolutions**—Subsamples the image for each dimension with lower resolution (i.e., larger pixel size) so that both images have the same resolution. To ensure that the fields of view remain the same, the program adds extra pixels to the image.
- **Match origins**—Adds margins to one of the images for each dimension if the origins (i.e., the starting location) of the two images are not the same. The program also adds pixels to the left, top, or front of the image.
- **Match image dimensions**—Adds pixels to the right, bottom, or back of either image so that they have the same dimensions.

You can select one or more of these choices in the dialog box. Before actually performing any selected comparison, MIPAV first checks to see whether the images do not already match in that regard. If they do, the given match is not performed.

To match image orientation

1. Open two images.
2. Select Utilities > Match images. The Match Images dialog box (Figure 264) opens.
3. Select one of the open images as image A, and select the other image as image B.
4. Select Match image orientations (based on imaging orientation).

5 Select any or all of the other check boxes to also, if desired, match image resolutions, origins, or dimensions.

6 Click OK. If the orientations of the images differ, the program changes the orientation of Image B to match that of image A.

To match image resolutions

1 Open two images.

2 Select Utilities > Match images. The Match Images dialog box (Figure 264) opens.

3 Select one of the open images as image A, and select the other image as image B.

4 Select Match image orientations (based on imaging orientation).

5 Select any or all of the other check boxes to also, if desired, match image resolutions, origins, or dimensions.

6 Click OK. If the resolutions of the images differ, the program changes the resolution of Image B to match that of image A.

To match image origins

1 Open two images.

2 Select Utilities > Match images. The Match Images dialog box (Figure 264) opens.

3 Select one of the open images as image A, and select the other image as image B.

4 Select Match image origins (by adding margins where necessary).

5 Select any or all of the other check boxes to also, if desired, match image orientations, resolutions, or dimensions.

6 Click OK. If the origins of the images differ, the program changes the origin of Image B to match that of image A.

To match image dimensions

1 Open two images.

2 Select Utilities > Match images. The Match Images dialog box (Figure 264) opens.

3 Select one of the open images as image A, and select the other image as image B.

4 Select Match image dimensions.

5 Select any or all of the other check boxes to also, if desired, match image orientations, resolutions, or origins.

6 Click OK. If the dimensions of the images differ, the program changes the dimension of Image B to match that of image A.

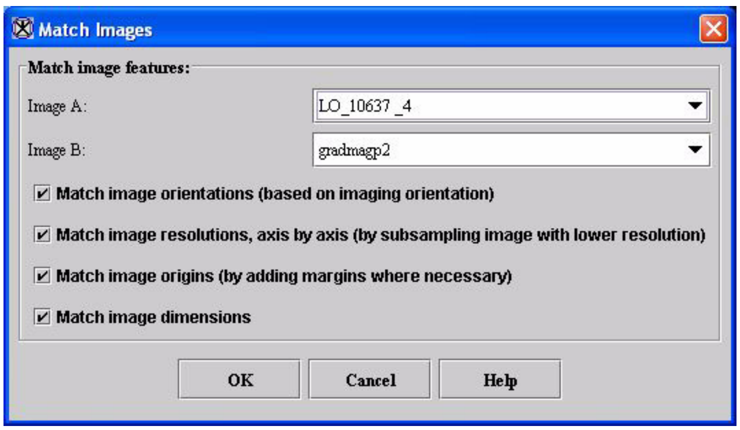


Image A	Specifies the image that contains the orientation, resolution, origins, or dimensions with which Image B needs to match.
Image B	Specifies the image on which to perform the image matching.
Match image orientations (based on imaging orientation)	Applies the image orientations (based on image orientation) used in Image A to Image B.
Match image resolutions, axis by axis (subsampling image with lower resolution)	Matches the image resolutions in Image A to Image B. Note that this subsamples Image A with a lower resolution if necessary.
Match image origins (by adding margins where necessary)	Matches the image origins used in Image A to Image B. Note that, if necessary, this adds margins to Image B.
Match image dimensions	Applies the image dimensions used in Image A to Image B.
OK	Applies the parameters that you specified to add margins to this image.

Figure 264. Match Images dialog box

Cancel	Disregards any changes you made in this dialog box, closes the dialog box, and does not perform image matching.
Help	Displays online help for this dialog box.

Figure 264. Match Images dialog box (continued)

Adding noise to images

Adding noise to images allows you to test the robustness and performance of an algorithm in the presence of known amounts of noise. When you select Utilities > Noise, the program clamps either Gaussian or uniform noise to the lowest or highest value in the source image type.

This class relies heavily on the Java Random class and is used to generate a stream of pseudorandom numbers. The class uses a 48-bit seed, which is modified using a linear congruential formula (refer to Donald Knuth, *The Art of Computer Programming*, Volume 2, Section 3.2.1.).

To add noise to images

1. Open an image on which you want to test the effectiveness of an algorithm.
2. Select Utilities > Noise in the MIPAV window. The program displays the Additive Noise dialog box (Figure 265).
3. Type the level of noise that you want to add to the image in the Noise level box. You can specify a value from 10 to 32,768.

Noise level (0-32768)	Specifies the level of noise to add to the image. The default value is 10.
Gaussian	Adds Gaussian or uniform noise to the image.
Uniform	Adds Uniform noise to the image.
New image	Shows the cropped image in a new image window.

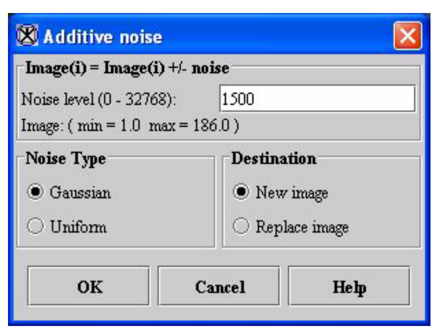


Figure 265. Additive Noise dialog box

Replace image	Replaces the current active image with the cropped image.
OK	Applies the parameters that you specified for adding noise to this image.
Cancel	Disregards any changes you made in this dialog box, closes the dialog box, and does not add noise to this image.
Help	Displays online help for this dialog box.

Figure 265. Additive Noise dialog box (continued)

4 Type the level of noise that you want to add to the image in the Noise level box. You can specify a value from 10 to 32,768.

5 Select either of the following:

- *Gaussian*—To add Gaussian noise to the image
- *Uniform*—To add Uniform noise to the image

6 Select either of the following:

- *New image*—To generate the resulting image in a new image window
- *Replace image*—To replace the current image with the resulting image

7 Click OK. The program adds the Gaussian or Uniform noise to the image and displays either a new image or replaces the current image with the one to which noise was added.

8 Select the algorithm in the Algorithms menu to test its effectiveness on the image.

Example. In the following example (Figure 266), the original image appears at the top of the figure. The next row shows the image on the left that results from adding Gaussian noise of 100. To its right is the image after running the Median algorithm. The image on the left on the last row results from adding Uniform noise of 100 to the original image. Running the Median algorithm on that image produces the image on its right. In this example, the Median algorithm performs better on an image containing Gaussian noise.

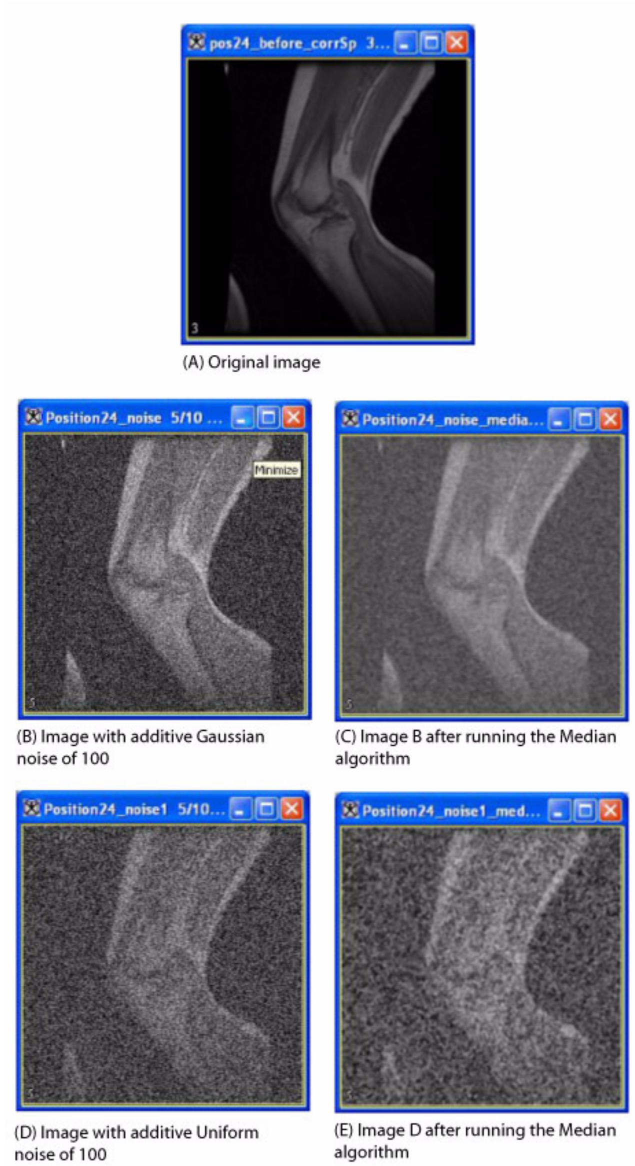


Figure 266. Examples of adding noise to an image and using it to test an algorithm's effectiveness in removing the noise

Randomizing image (slice) order

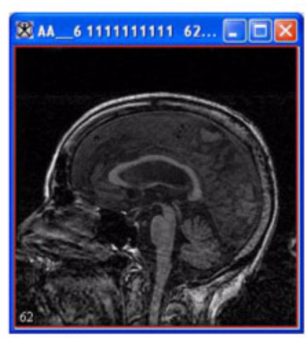
To randomize the order of slices in the image dataset, do the following:

1. Open an image that contains slices.
2. Use the image slider in the MIPAV window to locate slices that you want to remove.
3. Write the slice numbers on a piece of paper.
4. Select Utilities > Randomize Slice Order. A status message appears, and the system arbitrarily reorganizes the slices.

   A status message appears. Then the MIPAV window refreshes and, depending on your selection, the new dataset appears in either a new image window or in the same image window as the original dataset.

Rotating images

You can rotate images about the *x*, *y*, and *z* axes. For example, suppose that you opened the following image:



Original image

Figure 267. Original image to be rotated

To rotate images

1. Select Utilities > Rotate in the MIPAV window.
2. Select one of the following:
   - *X Axis +90:* To rotate the image about the *x* axis by +90 degrees.
   - *X Axis -90:* To rotate the image about the *x* axis by -90 degrees.
   - *Y Axis +90:* To rotate the image about the *y* axis by +90 degrees.
   - *Y Axis -90:* To rotate the image about the *y* axis by -90 degrees.
   - *Z Axis +90:* To rotate the image about the *z* axis by +90 degrees.
   - *Z Axis -90:* To rotate the image about the z axis by -90 degrees.

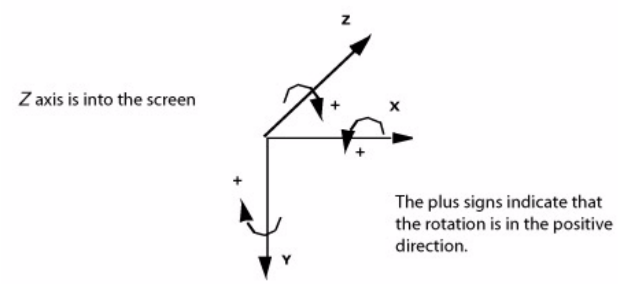


Figure 268. Rotation

A status message appears. When rotation is complete, the status window closes, and MIPAV replaces the original image in the image window with the rotated image.

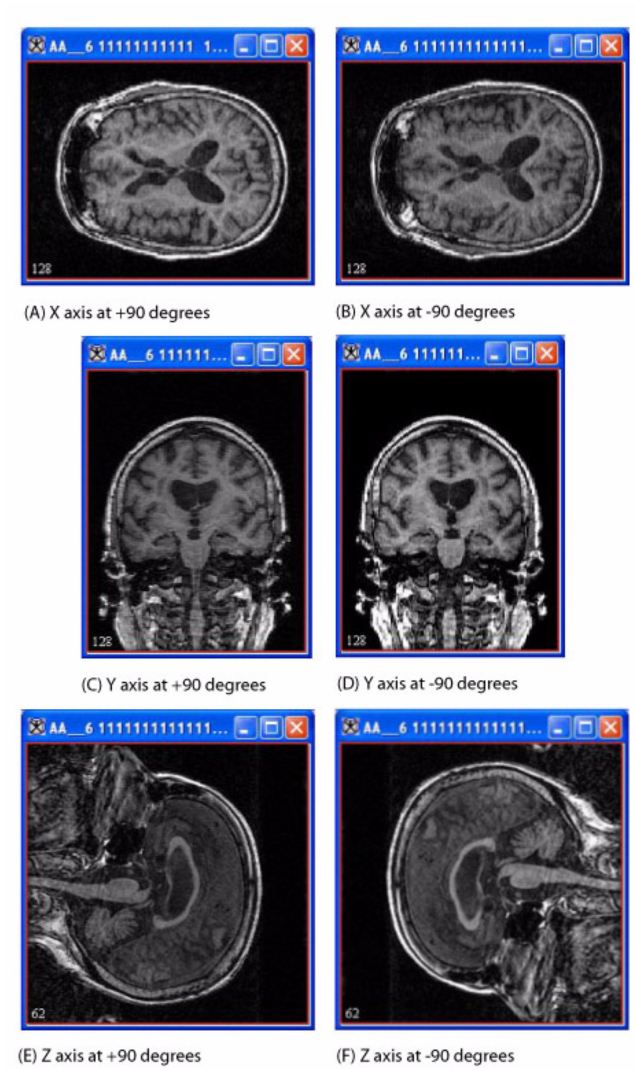


Figure 269. Examples of rotated images

This figure shows the image in Figure 267 at the six different types of x, y, and z rotation.

Removing images (slices) from datasets

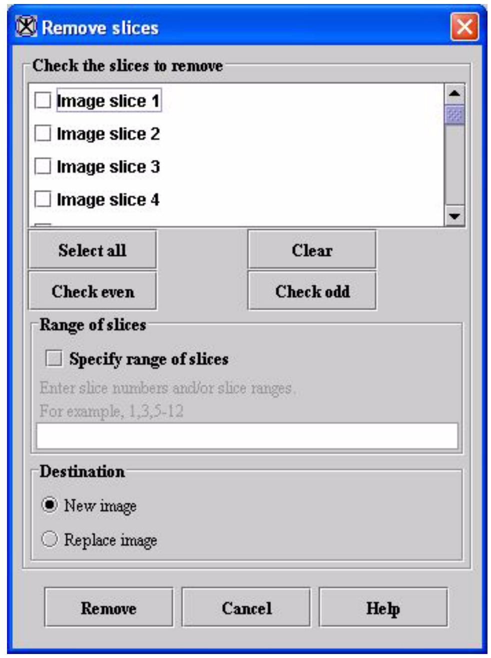
MIPAV allows you to remove one, several, or all slices from an image dataset. In addition, you can specify one or more ranges of slices to remove, or slice removal can include only the even-numbered or only the odd-numbered slices.

To remove slices from datasets

1. Select Utilities > Remove slices. The Remove Slices dialog box opens.
2. Use the image slider in the MIPAV window to locate slices that you want to remove.
3. Decide whether to remove:
   - One or more slices
   - Most of the slices
   - One or more ranges of slices
   - All even-numbered slices
   - All odd-numbered slices

Tip: Use the image slider on the MIPAV window to look at specific slices to decide which slices to remove.

4. Select one of the following:
   - *New image*—If the new image dataset should appear in its own image window
   - *Replace image*—If the dataset should overwrite the original dataset and appear in the original image window
5. Select Remove. A status message appears. Then the MIPAV window refreshes and, depending on your selection, the new dataset appears in either a new image window or in the same image window as the original dataset.



Slices	Indicates the slices that you want to remove from the dataset. You can scroll through the list to select one or more slices.
Select all	Selects all of the slices in the dataset.
Clear	Clears all of the slices that are currently selected.
Check even	Selects all of the even-numbered slices.
Check odd	Selects all of the odd-numbered slices.
Specify range of slices	Indicates that you want to remove one or more slices or a range of slices from the dataset. If you select this check box, you must specify the slices or ranges of slices you want to remove. in the Slice number or range of slices box below.
Slice number or range of slices	Indicates the specific slices and range of slices that you want to remove.
New image	Shows the results of the slice removal in a new image window.
Replace image	Replaces the current active dataset with the dataset resulting from the slice removal in the same image window.
Remove	Removes the slices that you indicated in this dialog box.
Cancel	Disregards any changes that you made in this dialog box and closes the dialog box.
Help	Displays online help for this dialog box.

Figure 270. Remove Slices dialog box

Removing time volumes

If an image dataset contains blank images or unusable images, which might be caused by patients blinking their eyes during tests, the Remove Time Volumes command on the Utility menu in the MIPAV window allows you to remove unusable images from the dataset.

To remove time volumes

1 Open an image dataset that contains time volumes.

Note: The Remove Time Volumes command only becomes active for 4D image datasets.

2 Use the image slider to look through the dataset one time volume, or image, at a time (Figure 271). If you find an unusable volume—one that is blank, or totally black, or that contains unusable information—stop moving the slider on that volume.

Note: The volume number appears in the title bar of the MIPAV window and correlates to the slice indicated by the image slider.

3 Select Utilities > Remove time volumes. The Remove Time Volumes dialog box (Figure 270 on page 407) opens.

4 Select the volume or volumes that you want to remove in the list at the top of the dialog box, or type the number of the slice or range of volumes in the Check the time slices to remove group box.

5 Do either of the following:

- Click Select all to remove all of the slices.
- Click Remove to remove the slices you selected.

  A status message appears. Then the MIPAV window refreshes.

6 Use the image slider again, if you'd like, to look through the slices in the dataset to verify that the appropriate slices were removed.

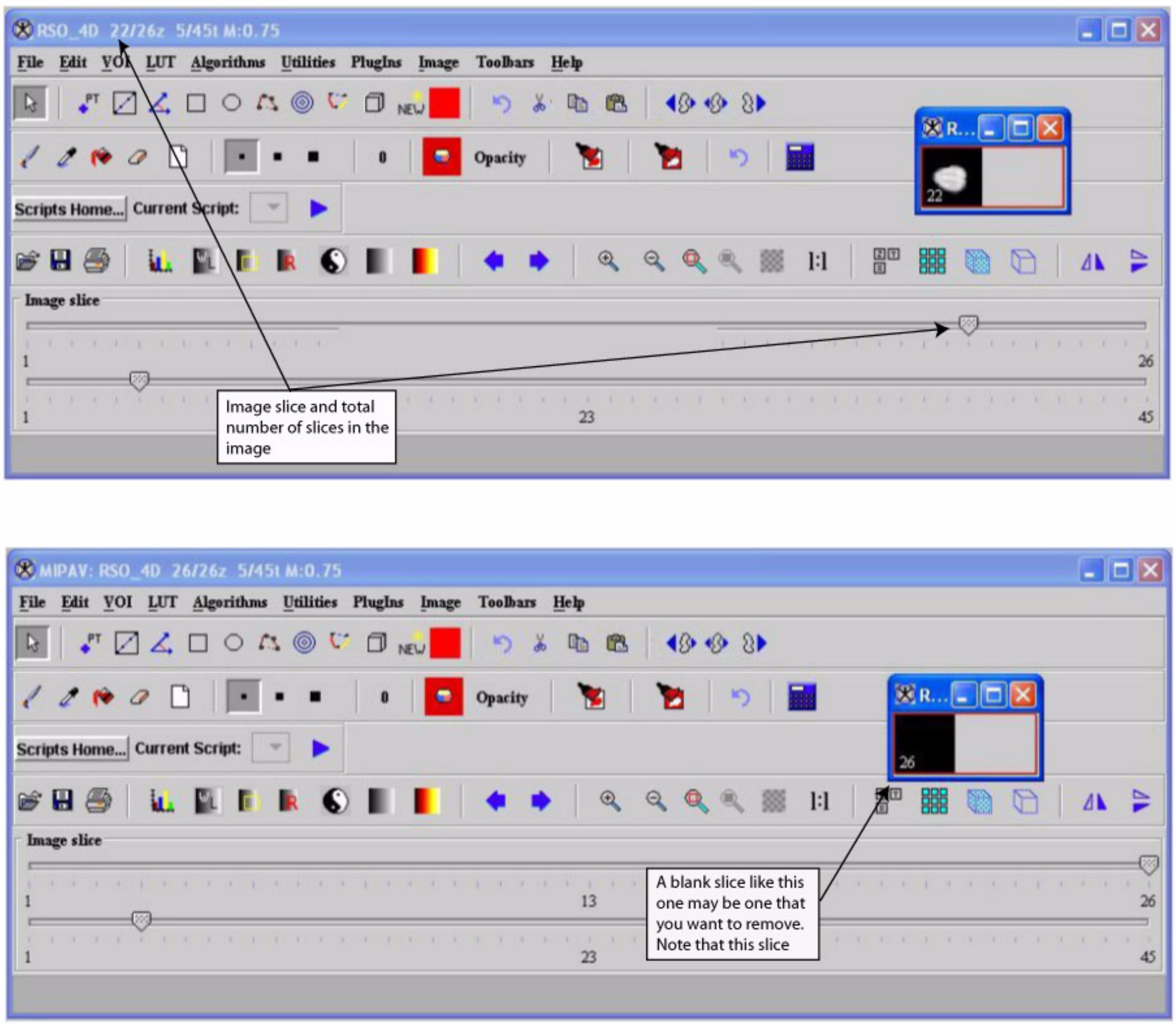


Figure 271. Using the image slider to look through an image dataset

Converting RGB datasets to grayscale datasets

On the Utilities menu in the MIPAV window, the RGB conversion utility offers both a manual and an automatic method of converting RGB datasets to grayscale RGB images.

- **Manual conversion**—In the manual method of conversion, you select Utilities > RGB > RGB -> Gray to display the RGB -> Gray dialog box (Figure 273). The dialog box provides three weighting methods:
  - *Equal weights*—This method assigns equal weights to each of the three color channels. When you select this option, you can also select the Only average RGB values greater than check box and specify a threshold value. For example, if you specify a threshold value of 50, the program ignores any pixel in that channel that contains a value over 50.

Note: You can only specify a threshold when you choose to use the equal weights method of conversion.

  - *Computer graphics weights*—This method assigns the weights to each channel that are typically used to display computer graphics.
  - *User-specified weights*—In this method, you enter the specific weights for each color channel.
- **Automatic conversion**—If, instead, you select Utilities > RGB > RGB -> Grays, the program automatically converts the RGB image to three grayscale images: one each for the red, blue, and green channels.

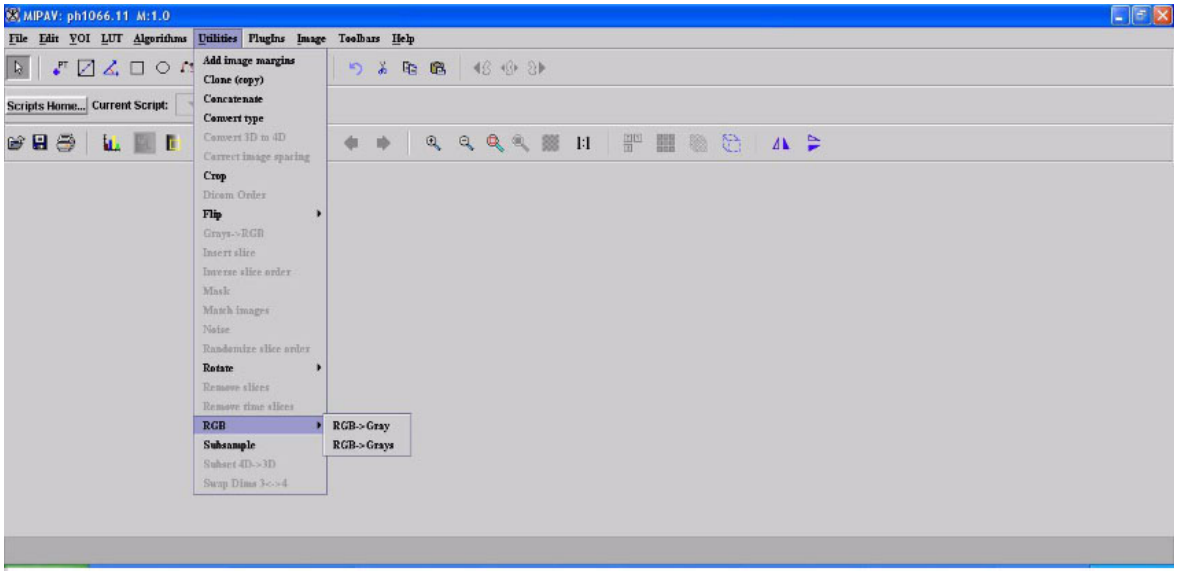


Figure 272. The Utilities > RGB menu

RGB datasets have four channels: red, green, and blue. When you convert RGB datasets to grayscale. RGB images, the intensities are combined to form a single grayscale value. For example::

$$N = R \times RW + G \times GW + B \times BW$$

where

N = New grayscale pixel

R = Red channel

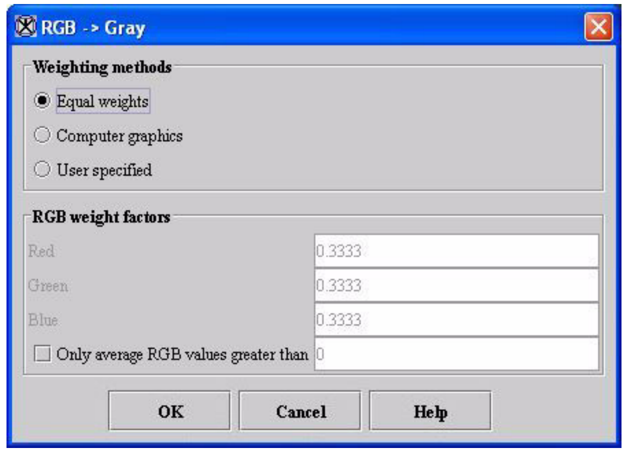
G = Green channel

B = Blue channel

RW = Weight assigned to the red channel

GW = Weight assigned to the green channel

BW = Weight assigned to the blue channel



Equal weights	Assigns the same weight (0.3333) to each channel in the image. When you select this option, the Only average RGB values great than becomes available.
Computer graphics	Assigns the weighting factors typically used in computer graphics to each channel in the image: • Red, 0.299 • Green, 0.587 • Blue, 0.114
User specified	Specifies a weight that you determine for each channel. When you select this check box, you must type a specific weight for each channel in the Red, Green, and Blue boxes.
Red	Specifies the weight assigned to the red channel in the image. You can only specify a weight in this box if you selected the User specified option.
Green	Specifies the weight assigned to the green channel in the image. You can only specify a weight in this box if you selected the User specified option.
Blue	Specifies the weight assigned to the blue channel in the image. You can only specify a weight in this box if you selected the User specified option.
Only average RGB values greater than	Excludes any voxel in the image over the threshold value that you specify in this box. This check box is only available when you select the Equal Weights option.
OK	Applies the parameters that you specified to create a grayscale image.
Cancel	Disregards any changes you made in this dialog box, closes the dialog box, and does not create a grayscale image.
Help	Displays online help for this dialog box.

Figure 273. RGB -> Gray dialog box

To manually convert RGB datasets to grayscale

1 Select Utilities > RGB > RGB -> Gray: The RGB -> Gray dialog box (Figure 273) opens.

2 Select one of the following weighting methods: equal weights, computer graphics, or user specified.

- If you selected Equal Weights, decide whether to apply a threshold to the RGB channels. If you want to apply a threshold, select Only average RGB values greater than and enter the threshold value. Then go to the next step.
- If you selected Computer graphics or User specified, go to the next step.

3 Click OK. A status message appears. In a few moments, the image is replaced by the new grayscale dataset.

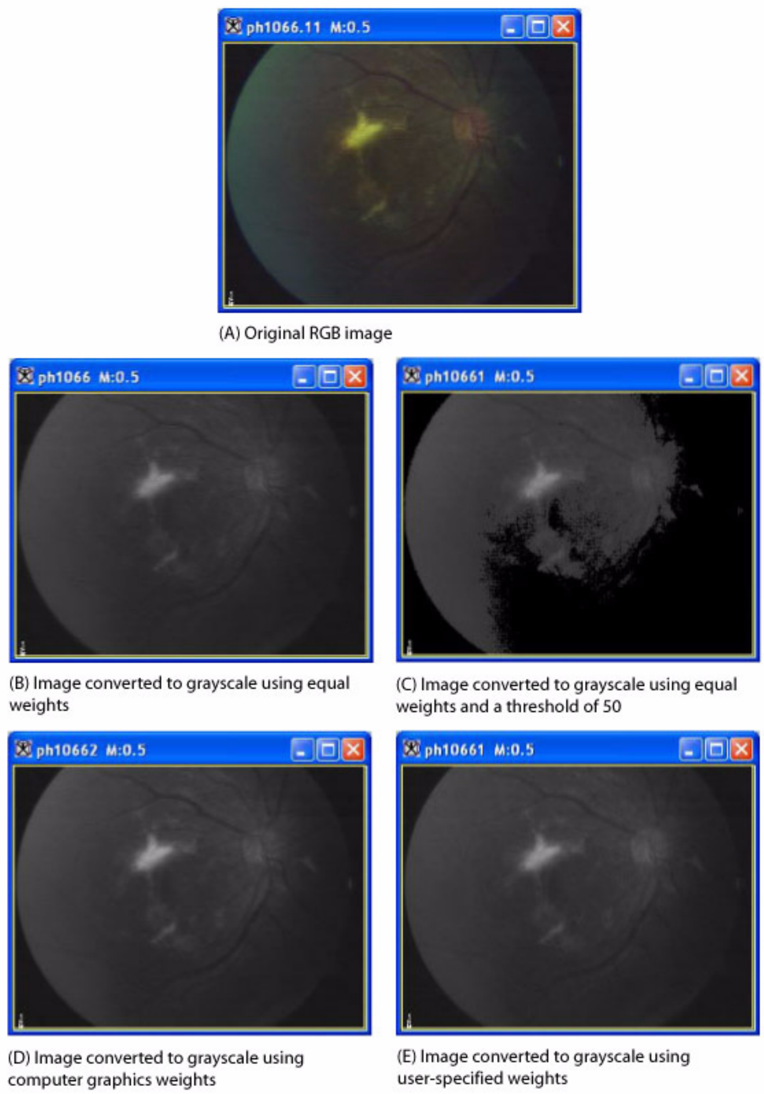


Figure 274. Manually converting RGB datasets to grayscale

To automatically convert RGB datasets to grayscale image

Select Utilities > RGB > RGB -> Grays. The program briefly displays a status message during the conversion and then generates three new grayscale datasets, one for each channel.

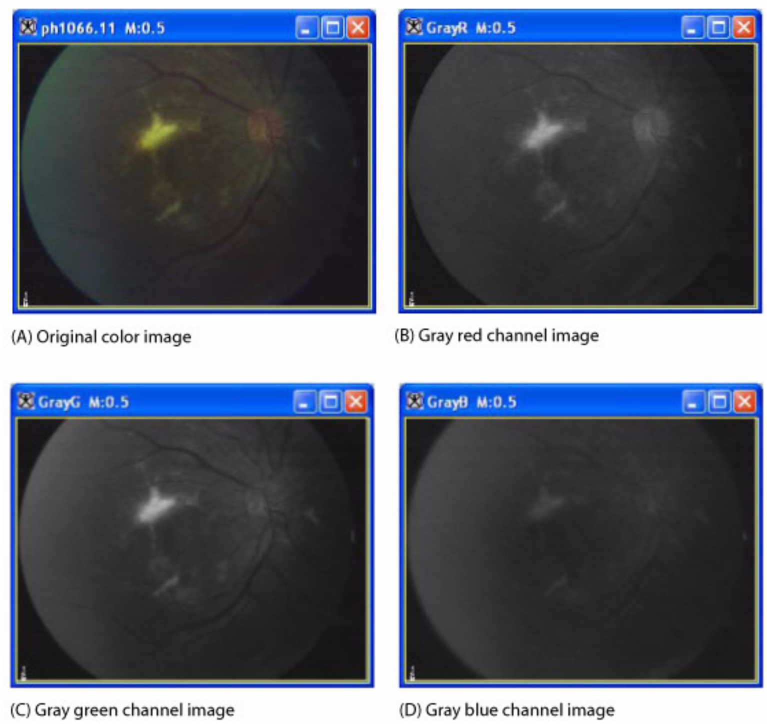


Figure 275. Example of three grayscale datasets generated automatically from an RGB dataset

Subsampling images

The subsample utility in MIPAV allows you to reduce an image in size by a factor of 2, 4, or 8 times. Each pixel of the subsampled image is a Gaussian-weighted average of the original image's 8 neighboring pixels for 2D images or 26 neighboring voxels for 3D images. For example, subsampling a 3D image with the *x*, *y*, and *z* dimensions of 256 x 256 x 32, respectively, by a factor of 2 produces a new image with *x*, *y*, and *z* dimensions of 128 x 128 x 16, respectively.

To subsample images

1 Open an image (Figure 276).

2 Select Utilities > Subsample. The Subsample dialog box (Figure 277) opens.

Figure 276. Original image before subsampling

3 Select one of the following:

- Subsample by 2
- Subsample by 4
- Subsample by 8

Subsample by 2	Subsamples each image dimension by a factor of 2.
Subsample by 4	Subsamples each image dimension by a factor of 4.
Subsample by 8	Subsamples each image dimension by a factor of 8.
Process each slice independently (2.5D)	Filters each slice of the dataset independently of adjacent slices.
OK	Applies the parameters that you specified to subsample the image.
Cancel	Disregards any changes you made in this dialog box, closes the dialog box, and does not subsample the image.
Help	Displays online help for this dialog box.

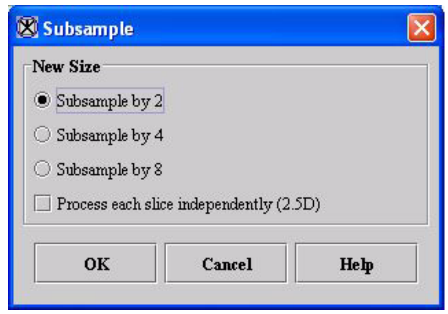


Figure 277. Subsample dialog box

4 Select, as an option for 2.5D images only, the Process each slice independently (2.5D) check box.

Tip: If you are *not* working with 2.5D images, the Process each slice independently (2.5D) check box does *not* appear in the Subsample dialog box.

5 Click OK. A status message appears briefly while the program generates the subsampled image in a new image window.

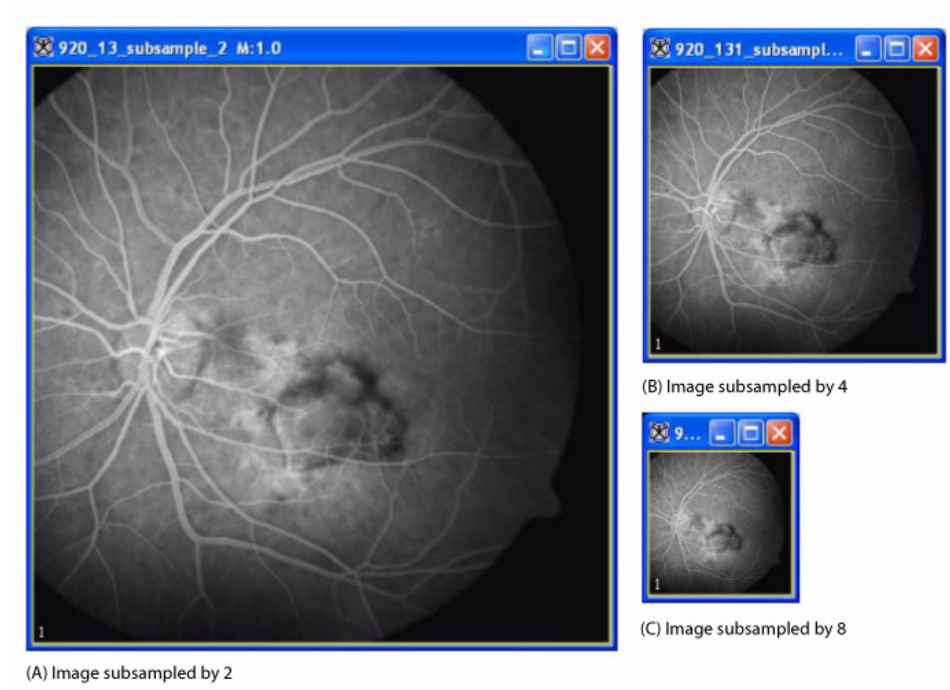


Figure 278. An image subsampled by 2, by 4, and then by 8

Swapping the third and fourth dimensions

Swapping the third and fourth dimensions refers to how image datasets are stored. Datasets may be stored using the following two methods:

- *xytz* (horizontal, vertical, time, third dimension)
- *xyzt* (horizontal, vertical, third dimension, time)

Because MIPAV requires that datasets be stored using the *xyzt* method, it provides the Swap Dims 3 <-> 4 command for those users whose datasets may be stored using the *xytz* method.

To swap the third and fourth dimensions

1. Open an image that is stored using the *xytz* method.
2. Select Utilities > Swap Dims 3 <-> 4. A progress message (Figure 279) appears briefly while the program changes the storage method of the image and replaces the image with one that is stored using the *xyzt* method.

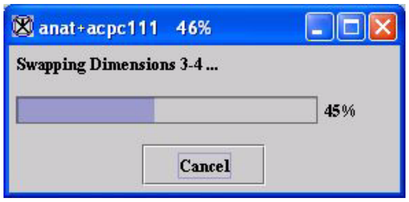


Figure 279. Progress message for swapping the third and fourth dimension